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CLAIMS

1. A device for checking logical software engines
for controlling and commanding plants, particularly
5 railway plants, particularly station plants, comprising
at least a computer with at least a central processing
unit and at least a memory for loading and executing
programs:
a logical engine for commanding a plant,
10 particularly a station plant, being loaded or loadable
in said memory for its execution, which plant comprises
a plurality of operating units for actuating and/or
detection and/or measurement and/or signalling, so-
called wayside equipments, which units are provided for
15 receiving command signals and for transmitting control
signals about the operating condition, and which
logical software engine reads control signals given by
the operating units for actuating and/or detection
and/or measurement and/or signalling and it processes
20 command signals of said operating units basing on an
operation protocol of the plant itself,
characterised in that
in the computer memory a plant software simulation
program that is to be controlled and commanded by the
25 control and command logical program is loaded or
loadable and it is executable by the computer itself
and which simulation program reproduces exactly the
plant structure and the operating modes of operating
units provided in said plant.

30   2. A device according to claim 1, characterised in

that the simulation of plant structure and of operating units associated thereto, such as track circuits to detect the presence of the train, switch points actuators, signalling actuators and other different

5   units is represented in the simulation program by Boolean algorithms, variables associated to said algorithms being univocally defined to represent the control signals of various state or operation conditions of several operating units and the command

10   signals for commutating and/or maintaining the state or operating conditions of said several operating units.

3. A device according to claims 1 or 2, characterised in that means for displaying the image of plant behaviour are provided under the control of the

15   control and command logical program as variable lists univocally associated to various operating units as report files wherein various operating units and the associated state or command variables are listed.

4. A device according to one or more of the

20   preceding claims, characterised in that the simulation program comprises means for setting starting operating conditions of the plant and/or even anomalous setting situations of plant operating units to check the reaction of the plant to these conditions.

25   5. A device according to one or more of the preceding claims, characterised in that to each plant operating unit and/or to each important structural element and/or at least to one or more areas of the plant and/or to the whole plant can be univocally

30   associated a virtual image of the operating unit and/or

of the plant structural element and/or of the area or areas of the plant and/or of the whole plant which image is generated by a graphic program loaded or loadable and/or executable by the computer of the

5 device and which virtual image is univocally correlated to the logical program for simulating the operating unit or the plant structural element or the area or areas of the plant or the whole plant, the graphic program for generating the virtual image of each

10 operating unit and/or of each area and/or of the plant being such to generate several graphic aspect conditions of the operating unit, of the area or of the whole plant each of them is univocally correlated to a predetermined value of variables relevant to the

15 operating condition of the operating unit or of the area or of the plant and/or of command variables for commutating or maintaining the operating state of the operating unit or of the area or of the plant.

        6. A device according to one or more of the

20 preceding claims, characterised in that the operation of the control and command logical program is further represented, in parallel or alternatively, as behaviour of the equivalent command hardware logic composed of a relay network, a program for simulating relay operation

25 and a program for simulating relay network operation being provided, as well as graphic programs for representing relays univocally associated to each relay simulation program and to relay network graphic representation program.

30   7. A device according to claim 6, characterised in

that each relay is simulated by a logical program of Boolean type, single state conditions of relays and/or commutation commands being represented by state or command variables and graphic programs being such to

5   associate several relay graphic aspects univocally correlated to values assumed by said state or command variables.

8. A device according to one or more of the preceding claims, characterised in that it has means

10   for scheduling and configuring images and/or state and command variable lists of virtual operating units corresponding to the desired or correct operation or state condition of the plant in conjunction with a predetermined operation situation, by providing means

15   for checking, directly and visually, a correct operation in conjunction with automatic check means basing on the comparison between the nominal image and the nominal table or list of desired state and command variables previously scheduled and the image and state

20   and command variables really processed during the operation of the control and command logic with the station plant virtual model, an error message being sent in case of non-identity.

9. A device according to claim 8, characterised in

25   that it has means for displaying graphically and/or analytically the operating unit or units that have assumed a non-correct condition and the corresponding state or command variable or variables.

10. A device according to claims 8 or 9,

30   characterised in that the automatic check means analyse

even the simulated representation means of the relay network, indicating which relay or relays have not been commutated in the correct condition and the corresponding commutation state or command variables.

5   11. A device according to one or more of the preceding claims, characterised in that it provides automatic means that correct the control and command logical program basing on the possible corrections made by the user to state or commands variables manually

10   modified in the presence of a state or command error of a virtual operating unit or of a relay in the corresponding command logical circuit formed by the plant or network relay virtual model.

     12. A device according to one or more of the

15   preceding   claims,   characterised   in   that   the modification means allow modification interventions both of alphanumeric type executed on report files of state or command variables, and interventions for graphically modifying the aspect of the operating unit

20   or the relay corresponding to the state of said operating unit or of said relay, whereas analyse and interpretation means are provided which analyse state or command variable values manually set to correct the wrong values, analyse the control and command logical

25   program and modify the code to commute the operating unit or relay in the correct state condition when the operation condition occurs with which the control and command logical program had previously generated the error.

30   13. A device according to one or more of the

preceding claims, characterised in that it comprises means for associating operating units and plant structural elements to generate or to find areas of virtual station plant and the corresponding parts of

5   the control and command logical program having typical plant structures that recur in several station plants, so as to load and reuse both the Boolean simulation programs, and graphic display programs as well as parts of control and command logical programs in new station

10   plants having equal station areas.

14. A device according to one or more of the preceding claims, characterised in that it has means for connecting and interfacing with validation and certification means based on the diversity of the

15   program for generating the control and command logical program, such as a so-called Boolean algorithms checker.

15. A device according to claim 14, characterised in that the Boolean checker comprises an additional

20   program for generating the control and command logical program generated or memorized in the Boolean checker which additional control and command logical program is generated through means different than the one during the test step by means of plant simulation and means

25   for comparing the additional control and command logical program generated or memorized in the Boolean checker with the control and command logical program during the test step by means of plant simulation to notice the identity between the two control and command

30   logical programs.

16. A device according to claim 15, characterised in that the comparison occurs at the Boolean equation system of the control and command logical program generated or memorized in the Boolean checker and at
5   the control and command logical program during the test step by means of simulation of the plant.

17. A device according to claims 15 or 16, characterised in that the comparison occurs according to text reports by means of plant simulation of the
10 control and command logical program during the test step and of the additional control and command logical program generated and/or memorized in the Boolean checker means being provided means for comparing command and state variables of operating units and
15 relays of the virtual relay network both from the numeric perspective and the graphic perspective.

18. A device according to claim 17, characterised in that it comprises means the displaying, in a combined way, of graphic images of plant state
20 conditions obtained with the two control and command logical programs.

19. A device according to claim 18, characterised in that it comprises means for displaying, in an overlap way, plant layout images according to the two
25 control and command logical programs, in which overlapping of the plant state condition image the possible differences are graphically highlighted in a visually relevant way.

20. A device according to one or more of the
30 preceding claims 15 to 19, characterised in that the

two comparison modes at the Boolean equation system and at report files of the test of control and command logical programs with the virtual plant are executed sequentially, the result of the first comparison being
5   a means to identify the operating unit and/or the plant area and/or the Boolean equations wherein a difference has been noticed and it must be subjected to the second comparison step.

21. A device according to claim 20, characterised
10 in that the comparison relevant to plant conditions obtained by the two control and command logical programs is firstly executed and therefore it is identified on which parts of the program the comparison actions can be limited with regard to the Boolean
15 equation system to determine possible actions to correct the same or the debugging.

22. A device according to one or more of the preceding claims 15 to 21, characterised in that the Boolean checker analyses, basing on diversity, even
20 logical programs for simulating the single operating units and/or the plant areas and/or the plant and/or the logical programs for simulating relays or relay network extending such check action, based on the diversity, of the generating program even to programs
25 for graphically representing operating units or relays.

23. A device according to one or more of the preceding claims, characterised in that it comprises a network interface and it may constitute a non-vital node of the railway plant, being a means for quickly
30 modifying the control and command logical program and

for virtually validating the same, for instance in case of a structural modification of the plant by eliminating or adding plant elements.

24. A device according to claim 23, characterised in that said device, alternatively or in conjunction, is a diagnostic or supervisory tool of the correct operation of the real station plant, being provided a comparator between the state condition that has been assumed by the real plant and the one that has been assumed by the simulated plant.

25. A device according to claims 23 or 24, characterised in that it is device for simulating emergency interventions before their application to the real plant, in the emergency event being possible to simulate several intervention or command possibilities of the plant to execute on the plant itself the among the possible choices the one that is the best solution.

26. A device according to one or more of the preceding claims, characterised in that it comprises tools for executing simulating functions with a user interface of the type used by the Windows ® program soft Inc. and therefore it comprises operating windows with function buttons, quick choice menus and other functionalities typical of said interface, in addition obviously to the use of mouse or of other pointers, selection and command input systems and the keyboard to input numerical data, such as to create or modify graphic images of operating units and/or of relays or of other parts of the plant structure.

27. A device according to one or more of the

preceding claims, characterised on that it provide means for setting specific operating conditions of the plant or of anomalous situations and for checking the plant reactions referring to several operating

5   environment.

28. A device according to claim 27, characterised in that manually setting means are means provided by the personal imposing at the starting of the cycle for executing control and command logical program specific

10   state conditions to the several operating units, being possible to provide by means of suitable scheduling even conditions wherein one or more operating units are not operating or operate in a anomalous way.

29. A method for checking software logical engines

15   for controlling and commanding plants such as railway plants, particularly station plants, comprising at least a central processing unit and at least a memory for loading and executing programs:

a logical engine for commanding a plant,

20   particularly a station plant, being loaded or loadable in said memory for its execution, which plant comprises a plurality of actuating and/or detection and/or measurement and/or signalling operating units, so-called wayside equipments, which units are provided for

25   receiving command signals and transmitting control signals as regards the operating condition, and which logical software engine reads control signals given by the actuating and/or detection and/or measurement and/or signalling operating units and it processes

30   command signals of said operating units basing on an

operating protocol of the system itself,

characterised in that

in the computer memory a program for software simulating the plant that must be controlled and
5   commanded by the control and command logical program is loaded or loadable and it can be executed by the computer itself and which simulating program reproduces exactly the plant structure and the operating modes of operating units provided in said plant.

10   30. A method according to claim 29, characterised in that the simulation of the plant structure and of the operating units associated thereto, such as track circuits to note the train presence, switch points actuators, signalling actuators and other different
15   units is represented in the simulating program by Boolean algorithms, variables associated to said algorithms being univocally defined to represent control signals of various state or operation conditions of various operating units and commutation
20   command signals of state or operating conditions of said various operating units and/or the maintenance thereof.

31. A method according to claims 29 or 30, characterised in that the image of the behaviour of the
25   virtual plant under the control of the control and command logical program is displayed as variables list univocally associated to various operating units as report files wherein various operating units and associated state or command variables are listed.

30   32. A method according to one or more of the

preceding claims 29 to 31, characterised in that it provides the setting by the user of starting operating conditions of the plant and/or even anomalous setting situations of plant operating units to check the
5   reaction of the plant to these conditions.

33. A method according to one or more of the preceding claims 29 to 32, characterised in that a virtual image of the operating unit and/or the plant structural element can be univocally associated to each
10   plant operating unit and/or to each relevant structural element which image is generated by a graphic program loaded or loadable and/or executable by the computer and which virtual image is univocally correlated to the simulating logical program of the operating unit or of
15   the plant structural element the graphic program for generating the virtual image of each operating unit being such to generate several conditions of graphic aspects of the operating unit, each of them is univocally correlated to a predetermined value of
20   variables relative to the operating condition of the operating unit and/or commutation or maintenance command variables of the operating state of the operating unit itself.

34. A method according to claim 33, characterised
25   in that the operation of the control and command logical program is further represented in parallel or alternatively as behaviour of the equivalent command hardware logic composed of a relay network, being provided a simulating program of relays operation and a
30   simulating program of relay network operation, as well

as graphic programs for representing relays univocally associated to each relay simulation program and relay network graphic representation program.

35. A method according to claim 34, characterised in that each relay is simulated by a logical program of Boolean type, individual state conditions of relays and/or commutation commands being represented by state or command variables and graphic programs being such to associate several graphic aspect of relays univocally correlated to values assumed by said state or command variables.

36. A method according to one or more of the preceding claims, characterised in that the display of the functional behaviour of the plant is executed according to two modes and i.e. in the shape of report file that displays values of state variables generated by the programs processed by the simulation logical programs of operating units and in the shape of graphic representation of the operating condition of operating units allowing to check in details the operating units of the plant and therefore the operation modes thereof both in an analytic way and in a direct visual way of the physical operation condition.

37. A method according to one or more of the preceding claims, characterised on that it provide means for setting specific operating conditions of the plant or of anomalous situations and for checking the plant reactions referring to several operating environment.

38. A method according to claim 37, characterised

in that settings can be executed by the personal imposing at the starting of the cycle for executing the control and command logical program specific state conditions to the several operating units, being 5 possible to provide by means of suitable scheduling even conditions wherein one or more operating units are not operating or operate in a anomalous way.

39. A method according to claim 37, characterised in that it provides the scheduling and the 10 configuration of images and/or state and command variables of virtual operating units corresponding to the desired or correct operation or state condition of the plant in conjunction with a predetermined situation of operation and the execution of the direct and visual 15 check of correct operation as well as the execution of an automatic check based on the comparison between the nominal image and the nominal table or list of desired state and command variables previously scheduled and the image and state and command variables really 20 processed during the operation of the control and command logic with the station plant virtual model, an error message being sent in case of non-identity.

40. A method according to claim 39, characterised in that the automatic check provides graphic and/or 25 analytic display of the operating unit that has assumed a non-correct condition and the corresponding state or command variable or variables and/or graphic and/or analytic display of state variables of the relay network simulated.

30   41. A method according to one or more of the

preceding claims 9 to 40, characterised in that it provides automatic tools correcting the control and command logical program depending on possible corrections made by the user to state or command

5 variables manually modified in the presence of a state or command error of a virtual operating unit or of a relay in the corresponding command logic circuit constituted by the relay network virtual model.

42. A method according to claim 41, characterised

10 in that it provides the execution of modification interventions both of alphanumeric type executed on report files of state or command variables, or graphic interventions for modifying the aspect of the operating unit or of the relay corresponding to the state of said

15 operating unit or of said relay said data being interpreted by a correction program that analyses state or command variables values manually set to correct those wrong, and that analyses the control and command logical program and modifies the colour to commutate

20 the operating unit or the relay in the correct state condition with the same operation condition in presence of which the control and command logical program had previously generated the error.

43. A method according to one or more of the

25 preceding claims, characterised in that it provides the read in of areas of the virtual station plant and the corresponding parts of the control and command logical program having typical plant structures that recur in various station plants, to load and reuse both Boolean

30 simulation programs, and graphic display programs as

well as parts of the control and command logical
program in new station plants having equal station
areas.

    44. A method according to one or more of the
5 preceding claims, characterised in that it provides the
alternative or parallel execution of a check of the
control and command logical program during the test
step with the plant simulator by means of a Boolean
checker that generates with diversity principles, or
10 wherein is memorized, a control and command logical
program generated with diversity principles and that
compares the control and command logical program during
the test step by means of virtual plant simulation with
the one generated with diversity criterions.

15   45. A method according to claim 44, characterised
in that it provides a further program for generating
the control and command logical program object of test
by means of plant simulation, which generating program
operates according to a code different from that with
20 which has been generated the control and command
logical program during the test by means of virtual
plant, the two control and command logical programs
being compared by the Boolean checker to identify
difference in the Boolean equation system.

25   46. A method according to claim 44, characterised
in that in addition or alternatively the control and
command logical program generate by the checker or
memorized therein is subjected to a test step by means
of virtual plant, being compared the results obtained
30 by the two control and command logical programs.

47 A method according to one or more of claims 44 to 46, characterised in that it provides the display, both in the shape of comparative tables of variables and in the shape of graphic comparisons, of the

5 operation differences of the two control and command logical programs generated according to diversity criterions and/or of the two relay networks corresponding to the two Boolean equation systems, being highlighted the variables and the graphic states

10 respectively that are different one with respect to the other both in the variable comparison and in the graphic comparison.

48. A method according to claim 47, characterised in that it provides the overlap of graphic images of

15 the plant state conditions obtained by the two control and command logical programs, being graphically highlighted the possible differences in this overlap of the image of the plant state condition.

49. A method according to one or more of claims 44

20 to 48, characterised in that it provide the execution alternative or in turn of the two modes for comparing the two control and command logical programs at the Boolean equation system and at the result of the test execution on the simulated virtual plant being also

25 possible to modify the sequence order of the two different comparison modes.

50. A method according to claim 49, characterised in that it provides the following comparison steps:

Firstly executing the comparison in relation to

30 the plant conditions obtained by the two control and

command logical programs;

Basing on said comparison identifying on which parts of the program the subsequent comparison actions can be limited;

5   Executing the comparison in relation to the Boolean equations of the two control and command logical programs only for the equations that caused the functional divergences that have been found in the first comparison step;

10   therefore executing the possible correction actions thereof or the debugging enquires (error detection) on said Boolean equations identified as responsible for the different behaviour of the plant.

51. A method according to one or more of the
15 preceding claims 44 to 50, characterised in that the actions for the comparison with a program generated according to a different generating code are executed also in relation to logical programs for simulating the individual operating units and the plant structure as
20 well as at logical programs for simulating relays and relay network and in case such check action may be also extended to the graphic representation programs of the operating units or of relays.

52. A method according to one or more of the
25 preceding claims 44 to 51, characterised in that it comprises parallel means for certificating the control and command logical program consisting in a further independent program that executes in parallel the test of the same Booleans equation system constituting the
30 control and command logical program to execute a double

test by means of the railway plant simulation, the behaviour of the simulated plant obtained under the control of the control and command logical program in the two separated and parallel check tests being

5   compared and alert or error files being generated in case of difference.

53. A method according to one or more of the preceding claims 44 to 52, characterised in that it comprises a step for operating connection to devices or

10   remote networks to command the test functions form a remote workstation and/or to execute alternative functions as functions of non vital node of railway plant.

54. A method according to claim 53, characterised

15   in that it is used for a modification to update a control and command logical program and for the virtual functional test thereof in case of structural modification of the plant.

55. A method according to claims 51 to 54,

20   characterised in that it is used for the supervision or the diagnostic of the correct operation of the real station plant, by executing a comparison between the state condition assumed by the real plant and that assumed by the simulated plant.

25   56. A method according to one or more of the preceding claims 50 to 55, characterised in that it is used as a virtual emergency simulator for intervention or command possibility of the real plant to realize on the plant itself only the choice that offers the best

30   solution among the possible choices.

57. A method according to one or more of the preceding claims 29 to 55, characterised in that it comprises a program for executing simulation functions with an user interface of the type used by Windows ®
5 program by Microsoft Inc. and hence comprising operating windows with function buttons, quick choice menus and other functionalities typical of said interface, in addition obviously to the use of the mouse or of other pointing means, selection and
10 inputting of commands and the keyboard to input numerical, alphanumerical data, and/or numerical or alphanumerical commands, such as also to create or modify graphic images of operating units and/or of relays or of other parts of the plant structure.

15   58. A program for a computer provided to verify a logical program for controlling and commanding a plant, particularly railway plant by means of application on a simulated railway plan that is provided to execute the method steps according to one or more of the preceding
20 claims 29 to 57 or to be loaded in the computer to form a device according one or more of the preceding claims 1 to 28.